Fast widely tunable chiral nematic liquid crystal filter

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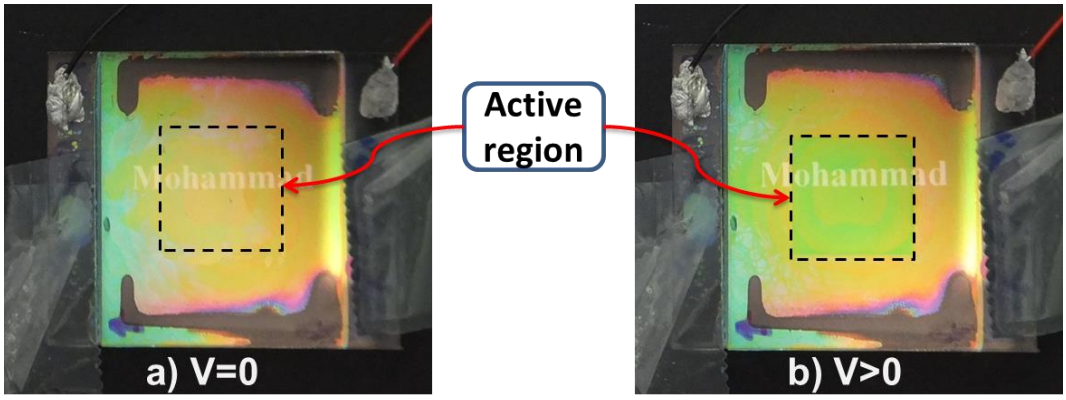
Chiral nematic liquid crystals (CLCs) can spontaneously arrange into helical structures with periodicities of a few hundred nanometers with a certain pitch (P) and corresponding periodic refractive index profile. As such they exhibit a reflection band for a certain wavelength interval $\Delta\lambda$ (= ΔnP) with P and Δn the birefringence. Since the photonic band gap (PBG) can be controlled by external stimuli (electricity, heat, light, elasticity), CLCs are potentially interesting in order to enable new applications: photonic information technology, lab-on-a-chip devices and switchable optical devices such as biosensors, reflectors, polarizers, reflective displays and tunable lasers.[1] In this work, a wavelength shift of the photonic band gap of 141 nm is obtained by electrical switching of a partially polymerized chiral liquid crystal with response times of 50 µs and 20 µs for switching on and off. The method features high stability and reflectivity in the photonic band gap without any noticeable degradation or disruption. The device consists of a mixture of photo-polymerizable liquid crystal, non-reactive nematic liquid crystal and a chiral dopant that has been polymerized with UV light. The influence of the amplitude and the frequency of the applied voltage on the width and the depth of the reflection band are investigated. By selecting the appropriate chiral dopant concentration, it is possible to make devices for different operation wavelengths. Compared to previously reported work, we have drastically improved the contrast and the switching speed of the device and the tuning range of the photonic bandgap.



A macroscopic photograph of a CLC orange reflector with 1×1 cm^2 active region placed on a black sheet on which the word Mohammad is printed, a) without and b) with applied electric field.

Reference:
[1] Inoue, Y.; Yoshida, H.; Inoue, K.; Shiozaki, Y.; Kubo, H.; Fujii, A.; Ozaki, M. *Adv. Mater.* 2011, **23**, (46), 5498-5501

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